

librium is disturbed, has, it would seem, a very general character. This has been demonstrated unequivocally in the work of the Solar Physics Committee, "Mean monthly values of barometric pressure," by N. Lockyer.¹⁵ C. Braak has investigated¹⁶ this in detail for the Dutch East Indies and has shown that it is reflected in both the

temperature and the pressure conditions as well as in precipitation, and that the periodic changes in the north-south gradients between Australia and the East Indies are the "faithful companions" of these pulsations.

It is not improbable that in this approximate 3.5 year period in the pulsations of the atmospheric circulation we are dealing with a phenomenon of extreme importance in the weather sequences of the longer periods of time.

¹⁵ Lockyer, N., Solar Physics Laboratory, South Kensington, 1908.
¹⁶ Braak, C., Periodische Klimaschwankungen, Meteor. Zeitschr., 1910, pp. 121-124.
 Die 3.5-jährige Barometerperiode, Meteor. Zeitschr., 1912, pp. 1-7.

TORNADO NEAR FITCHBURG, MASS., JULY 17, 1924¹⁷

By CHARLES F. BROOKS

(Clark University, Worcester, Mass., July 19, 1924)

551.515 (744)

About noon, July 17, 1924, with the arrival of the thundersquall on a marked wind-shift line, a tornado hit here and there along a path about 18 miles long from near Templeton, through Gardner, Westminster, southern Fitchburg, and Whalom, Mass. This course, averaging from west by south, when projected toward the east-northeast, passes near Lowell, Lawrence, Haverhill, and Newburyport, where torrential rain occurred shortly after. Here and there along the path there were groves of trees destroyed, factories nearly demolished, roofs and upper stories blown off, and chimneys generally blown down. So localized was the damage, however, that little was to be observed, for example, from the main thoroughfare from Leominster to Fitchburg across the storm path. Two were killed, and damage estimated at \$500,000 to \$1,000,000 was done, according to the Worcester Telegram.

While the local severity of the damage and the generally narrow and direct path in which destruction occurred, would lead one to suspect the action of a tornado, eye observation of the funnel cloud by Leroy Moreland and others at and near Whalom, and the criss-cross fall of forest trees there leave no doubt as to the whirling nature of the wind. With a geological compass I climbed over the fallen trees at Whalom, and obtained their direction of fall. Most were blown down from a west southwesterly direction, but near the northern edge of the zone of destruction, where the funnel cloud had been seen the trees were blown down from south and north as well as from west. A barn that was hit, blew down northwards, the north wall being blown out lower end first, and boards being carried a few tens of feet clear of the general wreckage.

A few details will be appropriate. After blowing down or partly wrecking some factories and tenements in the southern part of Fitchburg, the storm for the next 2 miles before reaching Whalom broke off or uprooted many large trees, blew down chimneys and damaged some roofs. A ball park fence was partly blown down, a tent carnival blown away, and a small grove of pines demolished, the trees generally being broken off half way up. Approaching Whalom, a large elm, well rooted, but exposed on a hill, was blown down from the southwest. The tree was about 3½ feet in diameter, and was said to have been growing there for at least 168 years. The upturned roots reached to a height of nearly 20 feet. A number of other trees were uprooted or blown down in this vicinity. A local resident said that another member of the family had seen a funnel cloud. At Whalom Park about half the trees (mostly pines 1 to 1½ feet in diameter) were blown down by uprooting or breaking. They lay mostly from southwest by west (compass bearing

W. 20°-30° S.), though a few lay on top from about west northwest (compass W. 30° N.). This was one-half to three-quarters mile south of the path of the funnel center. Across the road from Whalom Park, in a grove one-quarter to one-half mile from the path, about two-thirds of the trees were blown down. These were larger than those in Whalom Park, ranging up to 2 feet in diameter. About as many were broken off as uprooted. They were blown down from the same directions as those in Whalom Park, though there were more from the west northwest, perhaps a quarter of the total, as compared with only a few in Whalom Park.

A little farther north, at Sunnyside Farm, I came upon the region within the path of the funnel cloud. In describing the storm, Mr. Leroy Moreland, who with his father manages the farm, said he was between the two barns that were not blown down (the more southerly of three) when he saw what he thought at first was the smoke from a bad fire in the woods westnorthwest of him. There was a ragged cloud mass, whirling violently, coming straight towards him. It appeared white. It seemed to be bouncing up and down somewhat as it approached. Suddenly it turned at about a right angle just in time to avoid all but one of the barns. He had never before seen a cloud anything like that. The noise was terrific. Unfortunately for further observation of the storm, Mr. Moreland had to take shelter. He said the tornado struck at 12:20 or 12:25 p. m. (At Fitchburg, 2½ miles away the time of the storm was reported as 12:15.) Another man at the same farm said he saw a whirling cloud approaching, and that it had become extraordinarily dark. Others, at Whalom Park, had not seen the tornado cloud. Anyway, trees would have prevented their viewing it. One man with whom I talked said he had seen a small funnel cloud at Manchester, N. H., at about the time of the storm here.

The mixed forest through which Mr. Moreland had seen the funnel cloud came was about half destroyed, an open gap being cut about 50 feet wide from the west-northwest where the center passed. South of this gap some individual trees and clumps were blown down from the southsoutheast (compass bearing S. 5° E.), and a few from the southwest, but the great majority lay from between west by south and westnorthwest (compass W. to W. 30° N.). North of the gap about half the large and small oaks, maples, birches, etc., were down, mostly from the westnorthwest (compass W. 30° N.). There were several, however, from the northnorthwest (compass bearing N. 10° W.) under those from more westerly directions. From 250 to 300 yards beyond this was the barn that was blown down at about the place where the funnel cloud turned. About 50 yards south of this barn a silo had gone down and the corner of a barn roof had been blown off, while a few yards farther all seven chimneys of the well-built farmhouse had been blown

¹⁷ This is but a brief account. Clippings from the local press of important places affected, or nearby cities, and also a few photographs are on file at the U. S. Weather Bureau office, Boston, Mass. This published report is based on a brief tour of observation through the region of greatest damage near Fitchburg, and on some of the newspaper accounts for other portions of the path of the heavy storm.

flat. Just east to northeast of the barn that was blown down a young apple orchard had every tree in it uprooted, broken or bent from a southwesterly direction.

Although there was no complete destruction even in the direct path of the funnel cloud, the wide extent of considerable destruction, at Whalom upwards of three-fourths of a mile, was a notable feature of this storm.

The occurrence of severe winds and partial destruction by such winds here and there was reported, while the greatest damage farther on occurred in the Merrimac Valley from a cloudburst. The downpour began at Law-

rence at 12:45 p. m. (60th mer. time), and the darkness was extreme. This rain flooded and severely washed out a number of streets, and added to the damage of the hail in an immediately preceding storm.

In connection with the strong winds, presumably in one of the storms on this date a barrel was picked up, carried half a mile and deposited on top of a tall pole at Rye Beach, N. H. Such is the statement in the Worcester Evening Post, for July 29, under a photograph of the barrel in this position.

THE GREAT HAILSTORM IN SOUTHEASTERN NEW HAMPSHIRE AND NORTHEASTERN MASSACHUSETTS, JULY 17, 1924

551.578.7 (744)(742)

By B. M. VARNEY

(Weather Bureau, Washington, August 26, 1924)

The advance of the wind-shift line eastward from the region of tornado damage described in the previous article continued to be accompanied by violent convectional overturning, which caused severe thunderstorms, with falls of hail at Lawrence, Mass., said by old residents to be more remarkable than a great fall which occurred there on July 4, 1880. Following the hailstorm after an interval of about an hour, another thunderstorm added a rainfall of almost cloudburst intensity. The total precipitation recorded at Lawrence was 1.29 inches.

Press reports indicate that the severest disturbance (which was of tornado violence only in the area noted in the foregoing account) moved about east-northeast over a belt of country some 15 miles wide and lying largely north of the Merrimack River, which in this part of its course flows also about east-northeast. The southernmost damage reported by the press occurred in Andover, south of the river, and the northernmost in Salem, N. H. That the heaviest disturbance passed off the New England coast between Newburyport, Mass., and Portsmouth, N. H., is shown by the accounts of torrential rains and high winds at the former place, and of the depositing of the barrel on a telegraph pole at Rye Beach, N. H., as noted by Dr. Brooks. There are no reports of extraordinary conditions at Portsmouth. The movement thus indicated corresponds somewhat closely in direction with that of the center of the controlling cyclone, as nearly as that can be determined from the weather maps. At Blue Hill Observatory (640 ft. altitude) a maximum wind velocity of 72 miles per hour was recorded during the passage of the squall line.

On the maps herewith are shown the pressure distributions concerned, for 8 a. m. and 8 p. m., 75th meridian time, July 17, 1924. Arrows show the observed wind at selected stations (the initial letters of which are shown), the broken lines show the approximate positions of the wind-shift line, and the symbol of parallel lines on the 8 p. m. map the position of the belt (as well as it can be located from published reports) within which occurred the hail storm and the rainstorm here referred to and the tornado and high winds discussed in the foregoing paper.

The disturbance as reported from Lawrence and vicinity consisted of two distinct parts, as will be noted in the following quotation from the Lawrence Telegram of July 17, 1924: "Two of the most spectacular and unusual freak summer storms in the history of Lawrence visited the city within the short space of two hours Thursday and did damage that will run into the thousands of dollars.

"Nature sent a thunder and lightning storm about 11 o'clock calculated to strike terror into the stoutest of

hearts, when darkening skies, roaring thunder, flashing lightning, and sweeping rains were followed by a shower of hailstones varying from countless lumps of ice the size of marbles to thousands of larger ones as big as hen's eggs.

"The hailstorm in itself was thrill enough for one day, but the elements were not finished. At 12.45 a darkness as of night descended over the city, the thunder rumbled, the lightning flashed, and in a twinkling Lawrence was deluged in a fall of rain that was a veritable cloudburst. The rain swept down upon the darkened city in torrential sheets flooding the streets, overrunning the sidewalks and completely exceeding the capacity of the city sewers.

"The hailstorm was the most severe and unusual within the memory of the oldest resident of the city and the city underwent a veritable bombardment of icy pellets. Up to press time nobody had been reported injured, but that was nothing more or less than a miracle, because most of the icy stones falling were of a size sufficient to stun and injure anyone struck by them. To talk of hailstones as large as hen's eggs may seem like exaggeration to those who were not in the city during the storm, but thousands of local residents present can truthfully testify that they were the rule rather than the exception, while the sizes in odd cases ran to almost unbelievable extremes. [In Methuen and Salem counties lumps of ice larger than baseballs are reported to have fallen.—Ed.]. The Lawrence Common and lawns all over the city were covered after the storm with thousands of hailstones of all sizes.

"The places in this vicinity which suffered the worst were Salem, N. H., and Methuen, in the opinion of those who visited the different localities after the storm. North Andover and Boxford were hit hard also, but very little damage was caused in Lawrence or Andover except in isolated cases. The storm, which came from the north, cut a wide swath through Salem and Methuen. According to observers the storm struck Salem with all its force and then moved southward, striking the western section of Methuen, where it veered eastward and moved in the direction of Pleasant Valley across the northern and central section of the town. Near Pleasant Valley it swerved to the south across the Merrimack river, struck North Andover and Boxford and continued on toward Haverhill following the course of the river. Only the edge of the storm vortex [?] was felt in Lawrence and consequently the damage was not as heavy as in Methuen and Salem which felt the full force of the gale and the accompanying hailstones.

"An exact estimate of the damage caused by the storm is impossible because of the wide area affected and because in some localities the damage was so widespread that it